

USSN: 10/720,617  
Atty. Docket No.: 2003B125  
Amdt. dated May 2, 2005  
Reply to Office Action of November 30, 2004

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### Amendments to the Specification

Please replace paragraph [0001] with the following amended paragraph:

[0001] The present application is related by subject matter to U.S. Patent Application Serial No. ~~Awaited~~, 10,720,558, filed November 24, 2003 (Attorney Docket 2003B124) and U.S. Patent Application Serial No. ~~Awaited~~, 10/720,607, filed November 24, 2003 (Attorney Docket 2003B126) filed concurrently herewith, the entire contents of which applications are incorporated herein by reference.

Please replace paragraph [0017] with the following amended paragraph:

[0017] Conveniently, after at least one of (a) and (b), the support is calcined at a temperature of about 100°C to about 600°C.

Please replace paragraph [0023] with the following amended paragraph:

[0023] In addition, the catalyst composition includes ~~[[a]]~~ an indium component which is present in the catalyst composition in an amount such that the catalyst composition comprises at least 0.3% and less than 5.0%, for example at least 0.4% and less than 4.0%, such as at least 0.5% and less than 3%, of indium by weight of the total catalyst composition.

Please replace paragraph [0037] with the following amended paragraph:

[0037] The operating parameters of an alkyne/alkadiene selective hydrogenation process are not narrowly critical and can be controlled in view of a number of interrelated factors including, but not necessarily limited to, the chemical composition of the feedstock, the control systems and design of a particular plant, etc. (i.e., different reactor configurations including front-end, back-end, MAPD, and BD converters as mentioned briefly above). In general, however, suitable operating parameters include a temperature of from about 20°C to about 150°C, such as from about 30°C to about 100°C, a pressure of from about 100 psig to about 580 psig (690 kPa to

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4100 kPa), such as from about 200 psig to about 440 psig (1400 kPa to 3400 kPa), a  $H_2/C_2H_2$  molar feed ratio of from about 1 to about 1000, such as [[of]] from about 1.1 to about 800 and, assuming the reaction is in the vapor phase, a GHSV from about 100 to about 20,000, such as from about 500 to about 15,000 or, if the reaction is in the liquid phase, an LHSV of 0.1 to 100, such as from 1 to 25.

Please replace paragraph [0040] with the following amended paragraph:

[0040] In the case of a back-end selective hydrogenation reactor, the inlet operating temperature may range from about 30 to about 150°C, such as from about 40 to about 90°C. Representative operating pressures may range from about 100 psig to about 500 psig (about 690 to 3,500 kPa), such as from about 200 psig to about 400 psig (about 1400 to 2800 kPa). The GHSV may range from about 1000 to about 10,000, such as from about 3000 to about 8000. Further, the  $H_2/C_2H_2$  molar feed ratio may range from about 0.5 to about 20, such as from about 1.0 to about 1.5. The feedstreams in back-end selective hydrogenation processes may contain about 2% acetylene, about 70% ethylene, and the balance of other  $C_2$  compounds.

Please replace paragraph [0045] with the following amended paragraph:

[0045] This example illustrates the performance of a current state of the art commercial Pd-based catalyst. The catalyst, G-58C, was obtained from Sud-Chemie, Inc. and comprised 0.03wt% Pd and 0.18wt% Ag on alumina. The catalyst was evaluated under the following conditions: temperature = 100°C, pressure = 300 psig, GHSV = 4500,  $H_2/C_2H_2$  feed ratio = 1.1. The hydrocarbon feed contained nominally 1.65 mole % acetylene and 70 mole % ethylene, with balance being nitrogen. Impurities that may be present in the feed include carbon monoxide (<0.5ppm), mercury, arsine, phosphorus (<5 ppb), sulfur (<1ppm), oxygen (<1ppm), water (<10ppm), acetone (<10 ppm) and methanol (<2ppm). Test results are given in [[the]] Table 1 below.

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Please replace paragraph [0069] with the following amended paragraph:

[0069] In Example 20, the support was [zirconia-]titania-silica supplied by PQ Corporation and was used as received. The prepared rhodium chloride solution (122.3  $\mu\text{L}$ ) and indium chloride solution (53.5  $\mu\text{L}$ ) were mixed with deionized water (344.2  $\mu\text{L}$ ) and this mixed rhodium-indium solution (104  $\mu\text{L}$ ) was added to 105 mg of [zirconia-]titania-silica in a vial.

Please replace paragraph [0070] with the following amended paragraph:

[0070] In Example 21, the [zirconia-]titania-silica of Example 20 was used as the support and a rhodium-indium solution (104  $\mu\text{L}$ ) obtained by mixing the prepared rhodium sulfate solution (118.7  $\mu\text{L}$ ) and indium sulfate solution (63.5  $\mu\text{L}$ ) with deionized water (337.8  $\mu\text{L}$ ) was added to 105 mg of [zirconia-]titania-silica in a vial.

Please replace paragraph [0071] with the following amended paragraph:

[0071] In Example 22, the [zirconia-]titania-silica of Example 20 was used as the support and a rhodium-indium solution (104  $\mu\text{L}$ ) obtained by mixing the prepared rhodium sulfate solution (118.7  $\mu\text{L}$ ) and indium sulfate solution (63.5  $\mu\text{L}$ ) with deionized water (337.8  $\mu\text{L}$ ) was added to 105 mg of [zirconia-]titania-silica in a vial.

Please replace paragraph [0073] with the following amended paragraph:

[0073] The results in Table 4 show that nitrate precursors consistently produce significantly better catalysts than chloride and sulfate precursors and that alumina and zirconia are superior supports to silica, titania, [silica/zirconia]silica-zirconia and [titania/zirconia]titania-silica supports. The negative values in Table 4 are the result of the equations referred to above and used to calculate conversion and selectivity. Thus it will be appreciated that experimental error in measuring species concentrations can lead to the calculation of negative values in the above equations when conversions are extremely low.

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Please replace paragraph [0075] with the following amended paragraph:

[0075] When nitrate precursor salts were employed, the rhodium component was obtained by diluting rhodium nitrate (Strem chemicals, 10.01 wt % solution) with deionized water to 3.51 wt % rhodium, whereas the indium component was obtained by dissolving solid indium nitrate trihydrate (Prochem) in sufficient deionized water to give a solution containing 110.0 wt % indium. When a[[an]] rhodium oxoacetate precursor was used, this was prepared by adding hexa(acetato)-μ-oxotris(aqua)trirrhodium(III) acetate (Alfa, 0.88 g) added to 2.08 g glacial acetic acid and 1.32 g deionized water, whereafter the resultant mixture was shaken until all solid dissolved and then diluted with a further 9.54 g deionized water to afford a 2.47 wt % Rh solution. When a[[an]] rhodium acetylacetate precursor was used, this was prepared by dissolving rhodium (2,4-pentanedionate), i.e., rhodium(acetylacetonate), (Aldrich) in a mixture of methanol and 2,4-pentanedione such that the concentrations were 1.62 wt % rhodium and 23.0 wt % 2,4-pentanedione. An indium formate precursor was synthesized by refluxing indium hydroxide (Alfa, 3.20 g) with 60.72 g formic acid (Aldrich) in a round bottom flask with stirring overnight to obtain a homogeneous, colorless solution. The solvent was then evaporated by boiling the solution to leave an ~~off-white~~ off-white solid, whereafter the resultant solid indium formate was dissolved in a mixture of formic acid and water such that the indium concentration was 2.1 wt % and the concentration of formic acid was about 60 %.

Please replace paragraph [0076] with the following amended paragraph:

[0076] Details of the catalyst preparations are set out below[[:]].

Please replace paragraph [0084] with the following amended paragraph:

[0084] The results in Table 5 show that ~~ceria/alumina~~ ceria-alumina is a useful support material and that nitrate appears to be the best precursor for rhodium and nitrates and formates are good precursors for indium.

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Please replace paragraph [0086] with the following amended paragraph:

[0086] When the resultant catalysts were used to treat the same hydrocarbon feed under the same conditions as Example 1, the results shown in Table [[4]]6 were obtained.

Please replace the Abstract paragraph with the following amended Abstract:

[[An]] A selective hydrogenation catalyst composition comprises a rhodium component present in an amount such that the catalyst composition comprises less than 3.0% of rhodium by weight of the total catalyst composition; and an indium component present in an amount such that the catalyst composition comprises at least 0.3% and less than 5.0% of indium by weight of the total catalyst composition.

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Table 4

Example	Precursors	Support	C <sub>2</sub> H <sub>2</sub> conv (%)	H <sub>2</sub> conv (%)	C <sub>2</sub> H <sub>4</sub> select (%)	C <sub>2</sub> H <sub>6</sub> select (%)	Green Oil select (%)
6	Sulfates	Alumina	26.3	34.9	20.3	62.0	17.7
7	Nitrates	Alumina	83.8	93.4	59.7	34.7	5.7
8	Chlorides	Silica	0.8	1.0	29.6	64.4	6.0
9	Sulfates	Silica	-0.7	-0.1	129.8	-29.8	6.0
10	Nitrates	Silica	-0.7	1.9	150	-50	-21.2
11	Chlorides	Zirconia	46.3	63.0	21.9	63.9	14.2
12	Sulfates	Zirconia	8.2	12.0	-17.5	90.7	26.7
13	Nitrates	Zirconia	51.4	76.8	7.8	79.2	13.1
14	Chlorides	Titania	7.5	8.7	35.5	47.0	17.5
15	Sulfates	Titania	8.0	10.9	20.2	66.2	13.6
16	Nitrates	Titania	20.0	23.5	50.6	40.8	8.5
17	Chlorides	Zirconia-Silica	0.8	1.1	55.6	44.4	0
18	Sulfates	Zirconia-Silica	0.3	0.9	-50.0	150.0	18.0
19	Nitrates	Zirconia-Silica	1.5	2.2	63.6	33.1	3.3
20	Chlorides	[Zirconia-]Titania- Silica	0.9	1.4	28.8	64.2	7.0
21	Sulfates	[Zirconia-]Titania- Silica	0.3	2.4	-50	150.0	27.1
22	Nitrates	[Zirconia-]Titania- Silica	-0.3	2.4	150	-50.0	-50.0

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**Support for Amendments to the Specification**

The amendments to the specification are responsive to the Office Action to provide patent application serial numbers which had not yet been assigned and to correct minor grammatical errors.

Paragraphs [0069] through [0071] and [0073] and Table 4 have been amended to correct an inadvertent error in reporting the support material and to include the missing supplier name. Applicants respectfully submit that these amendments are necessary for accuracy of disclosure and that no new matter has been added with respect to the claimed invention, as the examples being corrected show a material which is not presently and will not in the future be individually claimed in the present application. Applicants will submit documentation separately to further support this amendment.